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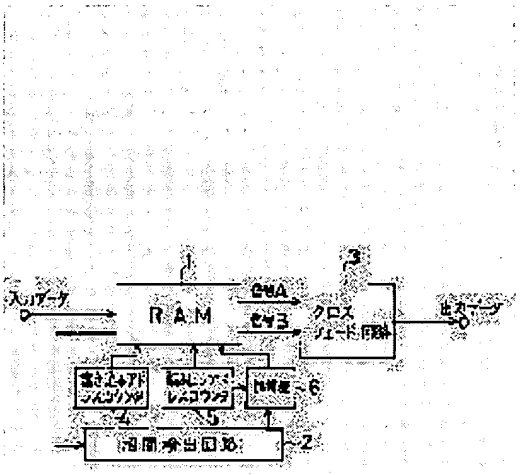
(54) PITCH CONVERTER FOR DIGITAL AUDIO SIGNAL

(57)Abstract:

PURPOSE: To obtain the pitch converter of high quality for the digital audio signal which performs processing with small deterioration due to tremolo modulation, a phase shift, etc., by enabling continuation by cross-fading at the highest- correlation position obtained by a correlation detecting means.

CONSTITUTION: An input signal is written and stored in a RAM 1 according to the write address given from a write address counter 4. The correlation detecting circuit 2 finds cross-fading sections before and behind an editing point and correlation nearby a temporary editing point from the signal stored in the RAM 1 to detect the position where the highest correlation is obtained, regards the position as an editing point, and sends the length of a section where compression is performed with the difference between both the editing points to an adder 6. Thus, the cross-fading is performed at the position of the highest correlation to make a connection. Consequently, attenuation due to a difference in phase is eliminated in the cross-fading section to prevent the tremolo modulation.



LEGAL STATUS

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[Date of final disposal for application]	
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[Date of registration]	16.06.2000
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the pitch converter of the digital audio signal which performs pitch conversion of a digital audio signal.
[0002]
[Description of the Prior Art] In order to perform time edit, without changing a pitch at the time of edit of a digital audio signal, it is necessary to perform time-base-compaction elongation. Moreover, in order to change a pitch into the musical interval which is easy to sing at a karaoke place etc., without changing the rate of music, it is necessary to perform pitch conversion. Generally, the same actuation can perform time-base-compaction elongation and pitch conversion fundamentally.
[0003] Drawing 6 shows the relation between time-base-compaction elongation and pitch conversion. It is what showed signs that pitch conversion to which drawing 6 (b) lowers a frequency in drawing using time base compaction was performed. Store in memory the signal which performed [the signal of a frequency f and time amount t] compression for time amount to t1 (<t) from t by the frequency regularity f by time base compaction, and it reads with a different sampling frequency from the time of writing. By returning the time amount of a signal to the time amount t of a basis, the pitch conversion of the frequency of a signal can be carried out from f f1 (<f).
[0004] Drawing 6 (b) is what showed signs that pitch conversion which raises a frequency using time-axis elongation was performed similarly. Store in memory the signal which elongated time amount for the signal of a frequency f and time amount t from t to t2 (<t) by the frequency regularity f with time-axis elongation, and it reads with a different sampling frequency from the time of writing. The frequency of a signal can carry out pitch conversion from f by returning the time amount of a signal to the time amount t of a basis f2 (<f).
[0005] Generally, in the pitch transducer, data are written in RAM and pitch conversion is performed by reading with a different speed from writing. When performing pitch change by such approach, and the write-in address reads and the address is exceeded, since the rates of writing and read-out differ, or when the readout address writes in and the address is exceeded, a break point is produced in an editing point.
[0006] Drawing 7 is drawing having shown signs that a break point was produced. In drawing, as for the editing point a, the data readout location of the jump place in the case of lowering a frequency and the editing point b2 show the data readout location of the jump place in the case of raising a frequency, as for the data readout location before a jump, and the editing point b1. Moreover, Signal A and the signal after a jump are made into Signal B for the signal before a jump.
[0007] In lowering a frequency, it produces a break point as shown in the drawing 7 (**) by the jump to the editing point b1 from the editing point a, and in raising a frequency, it produces a break point as shown in drawing 7 (Ha) by the jump to b2 from the editing point a. This break point serves as a clicking noise. In order to prevent such a clicking noise, cross fade and the zero cross method are proposed. A pitch converter is explained focusing on the case where perform time base compaction and a frequency is lowered, the back [this].
[0008] Drawing 8 is drawing having shown the conversion part of the conventional pitch converter shown for example, in the JP,03-31279,B public notice, and is set to drawing. RAM 1 remembers an input signal to be, the write-in address counter which gives the address with which 4 writes an input signal in RAM1, The read-out address counter which gives the address of the signal which reads 5 from RAM1, the constant adder which 30 is read [adder] to a certain

fixed edit location, and makes the value of the address jump, and 3 are cross fade circuits which connect by cross fade processing in an editing point.
[0009] Next, actuation is explained. According to the write-in address which writes in an input signal and is given by the address counter 4, it writes in RAM1 and memorizes. According to the read-out address given from the read-out address counter 5, Signal A is read from the address of the beginning of RAM1, and Signal B is read from the address made to jump by reading the die length of the fixed compression section to coincidence with the constant adder 30, and adding to the address. Cross fade processing is performed for this Signal A and Signal B before and behind an editing point in the cross fade circuit 3, and the data after compression are outputted.
[0010] Here, by applying the multiplier of 0 to 1 in the cross fade section, and adding Signal A and Signal B, an editing point is processed and this prevents a clicking noise so that fade-in of fade-out and the signal B may be carried out for Signal A to cross fade processing before and behind an editing point, as shown in drawing 9 .
[0011] Drawing 10 is drawing having shown the conversion part of the conventional pitch converter shown for example, in the JP,60-35795,A official report, and they are the zero cross detector which 40 detects the zero crossing point of the temporary edit neighborhood of a point, and flies the address to edit, and the adder which 6 is read [adder] to an edit location according to the output from the zero cross detector 40, and makes the value of the address jump in drawing.
[0012] Next, actuation is explained. According to the write-in address which writes in an input signal and is given by the address counter 4, it writes in RAM1 and memorizes. zero crossing point a' near [as shown in drawing 11 in the zero cross detector 40 from the signal memorized by RAM1] the temporary editing points a and b, and b -- ' -- detecting -- Find the die length of the section which performs compression from the difference of b' and a', and it sets in the location of zero crossing point a'. Add to the read-out address which reads the die length of the compression section with an adder 6, and is given by the address counter 5, b' is made to jump the address, and the data after compression are outputted by reading data from RAM1. By connecting in a zero crossing point, the zero cross method processes an editing point and aims at reduction in a clicking noise.
[0013]
[Problem(s) to be Solved by the Invention] The trouble at the time of processing an editing point using the conventional cross fade is explained below. Drawing 12 is drawing having shown attenuation of the envelope of the data after the processing at the time of performing cross fade processing. Although the signal after cross fade processing is finely connected in the cross fade sections a and b when cross fade is performed as shown in drawing 12 (b) If the phase of a signal has shifted like [at the time of performing cross fade by the cross fade section a and b'] By the signal of the cross fade sections a and b negating each other, the envelope of the signal after cross fade processing declining in the cross fade section, as shown in drawing 12 (b), and repeating this attenuation As the audibility top tremolo modulation started, ****** tone quality deteriorates.
[0014] moreover, when an editing point is processed using the zero cross method, a noise cannot be removed completely, but since the zero cross locations of Lch and Rch differ in constituting the pitch converter of a stereo specification further, the phase shift which it is between Lch and Rch is produced -- like -- there was a trouble.
[0015] It was made in order that this invention might cancel the above troubles, and it aims at obtaining the pitch converter of the quality digital audio signal which performs little processing of degradation by the tremolo modulation, a phase shift, etc.
[0016]
[Means for Solving the Problem] The pitch converter of the digital audio signal concerning invention of claim 1 establishes a means to detect correlation near an editing point, and connects by cross fade in the location which is obtained by the correlation detection means and where correlation is the highest.
[0017] The pitch converter of the digital audio signal concerning invention of claim 2 A means to be the pitch converter of the digital audio signal of a stereo specification, and to detect correlation near the edit location of Lch, A means to detect correlation of Rch in the edit neighborhood of a point of Lch which became settled previously is established. Lch is connected by cross fade in the location which is obtained by the correlation detection means of Lch and where correlation is the highest, and Rch is connected by cross fade in the high location of most correlation near the editing point of Lch obtained by the correlation detection means of Rch next.
[0018] The pitch converter of the digital audio signal concerning invention of claim 3 It is the pitch converter of the digital audio signal of a stereo specification which edits by cross fade in the high location of correlation of an audio

signal. So that it may edit by establishing a means to detect the cross-correlation between 2ch(es) of LchRch in the location where most correlation is high at Lch and Rch independence according to correlation between 2ch(es), when correlation is low Moreover, when correlation is high, the edit approach is changed accommodative so that 2ch(es) may be edited in the location [Lch / (Rch)] where correlation is the highest.
[0019]
[Function] Since a means to detect correlation near [in invention of claim 1] an editing point detects the location where correlation is the highest and connects by cross fade in the location, it prevents a tremolo modulation and a clicking noise, and realizes little quality pitch conversion of degradation.
[0020] A means to detect correlation near [in invention of claim 2] the editing point of Lch, and a means to detect correlation of Rch near the Lch Lch is connected by cross fade in the location which is obtained by the correlation detection means of Lch and where correlation is the highest. Next, quality pitch conversion with few tremolo modulations is realized within limits which do not produce a phase shift if possible near the editing point of Lch obtained by the correlation detection means of Rch since Rch is connected by cross fade in the high location of most correlation.
[0021] A means to detect the cross-correlation between 2ch(es) of LchRch in invention of claim 3 According to correlation between 2ch(es), when correlation is low, most by Lch and Rch independence, so that it may edit in a mutually related high location Moreover, since the edit approach for which it was more suitable according to correlation between 2ch(es) of edit music is chosen so that 2ch(es) may be edited in the location [Lch] where correlation is the highest when correlation is high, little quality pitch conversion of degradation by the phase shift and the tremolo modulation is realized.
[0022]
[Example]
drawing having shown the configuration of the transducer of the pitch converter of the digital audio signal whose example 1. drawing 1 is one example of invention of claim 1 -- it is -- drawing -- setting -- 2 -- edit -- the actual making of the tea -- it is the correlating detector which detects correlation of the next cross fade section. Here, correlation may be a scale which shows two wave-like similarity, for example, the correlation function which computes the sum of the product between the samples to compare may be used, and the size comparison of the value of a correlation function performs a wave-like similar comparison.
[0023] Drawing 2 is drawing showing the editing point on the wave form chart of the audio signal of 1ch in this example, the cross fade section and compression, and the elongation section, and, as for drawing 2 (b), in compression, drawing 2 (b) shows the case of elongation.
[0024] Next, actuation is explained. According to the write-in address which writes in an input signal and is given by the address counter 4, it writes in RAM1 and memorizes. Correlation of the cross fade section before and behind the editing point a1 and a near [the temporary editing point b1] is searched for in the correlation detector 2 from the signal memorized to RAM1, the location where correlation is the highest is detected, the location is made into editing point b1', and the die length of the section which compresses with the difference of editing point b1' and the editing point a1 is sent to an adder 6.
[0025] RAM1 reads Signal B from the address made to jump by reading Signal A from the first address according to the read-out address given from the read-out address counter 5, reading the die length of the compression section sent to coincidence from the correlation detector 2 with an adder 6, and adding to the address. The cross fade circuit 3 performs cross fade processing for this Signal A and Signal B before and behind the editing point a1, and outputs the data after compression.
[0026] Next, the edit actuation in the case of elongating is explained. Can edit by the actuation as the case of compression that it is the same also in elongation, and as shown in drawing 2 (b), the correlation detector 2 searches for correlation of the cross fade section before and behind the editing point a2, and a near [the temporary editing point b2 of a section quota to elongate] from the signal memorized to RAM1. The location where correlation is the highest is detected, the location is made into editing point b2', and it sends to an adder 6 in quest of the die length of the section which develops with the difference of editing point b2' and the editing point a2. RAM1 reads Signal B from the address made to jump in front by reading Signal A from the first address according to the read-out address given by the read-out address counter 5, reading the die length of the elongation section sent to coincidence from the correlation detector 2 with an adder 6, and subtracting from the address. Cross fade processing is performed for this Signal A and Signal B

before and after the editing point a1 in the cross fade circuit 3, and the data after elongation are outputted.
[0027] According to this example, by connecting in a mutually related high location, applying cross fade, attenuation by the difference in a phase is lost in the cross fade section, and a tremolo modulation can be prevented.
[0028] Invention of example 2. claim 2 relates to the pitch converter of the digital audio signal of a stereo specification. Drawing 3 is drawing having shown the configuration of the transducer of the pitch converter of the digital audio signal which is one example of this invention, and is set to drawing. RAM 10 remembers a Lch input signal to be, and 11 -- edit of Lch -- the actual making of the tea -- the correlating detector which detects correlation of the next cross fade section -- The cross fade circuit where 12 connects by cross fade processing in the editing point of Lch, RAM 13 remembers a Rch input signal to be, and 14 receive the data of Rch. the edit of Rch in the temporary edit neighborhood of a point made into the editing point and corresponding value of Lch -- the actual making of the tea -- the correlating detector which detects correlation of the next cross fade section -- The write-in address counter which gives the address with which 16 writes an input signal in RAM13, The read-out address counter which gives the address of the signal which reads 17 from RAM13, The adder which 18 is read [adder] to an edit location according to the output from the correlation detector 14 of Rch, and makes the value of the address jump, and 15 are cross fade circuits which connect by cross fade processing in the editing point of Rch.
[0029] Drawing 4 is a wave form chart for explaining edit actuation of this example.
[0030] Next, actuation is explained. According to the write-in address given from the write-in address counter 4 and the write-in address counter 16, respectively, a Lch input signal and a Rch input signal are written in RAM10 and RAM13, and are memorized. The Lch correlation detector 11 is the editing point al about the data of Lch memorized to RAM10. The cross fade section of order, and temporary editing point bl Neighboring correlation is searched for, the location where correlation is the highest is detected, the location is made into editing point bl', and it sends to an adder 6 in quest of the die length of the section which compresses with the difference of editing point bl' and the editing point a1. RAM10 reads Signal aluminum from the first address according to the read-out address given by the read-out address counter 5, and reads Signal Bl from the address made to jump by reading the die length of the compression section sent to coincidence from the Lch correlation detector 11 with an adder 6, and adding to the address. The cross fade circuit 12 performs cross fade processing for this Signal aluminum and Signal Bl before and behind the editing point al, and is ****** about the Lch data after compression.
[0031] Next, as the Rch correlation detector 14 is shown in drawing 4 (b) about the data of Rch memorized to RAM13, correlation near the editing point br of Lch, Lch sent from a Lch correlation detector to the cross fade section before and behind the editing point ar of homotopic, and a corresponding value is searched for. The location where correlation is the highest is detected in near, the location is made into editing point br', and it sends to an adder 18 in quest of the die length of the section which compresses with the difference of editing point br' and the editing point ar. RAM13 reads Signal Ar from the first address according to the read-out address given by the read-out address counter 17, and reads Signal Br from the address made to jump by reading the die length of the ****** compression section to coincidence from the Rch correlation detector 14 with an adder 18, and adding to the address. The cross fade circuit 15 performs cross fade processing for this Signal Ar and Signal Br before and behind the editing point ar, and outputs the Rch data after compression.
[0032] According to this example, by giving the information about the editing point of Lch to a Rch correlating detector, and editing in the high location of most correlation by that near, the phase shift by the difference in the editing point of Lch and Rch can be stored in the range without an audibility top problem, and a tremolo modulation can be decreased.
[0033] Although correlation was searched for focusing on Lch, you may go by the above-mentioned example focusing on which of Lch and Rch.
[0034] Invention of example 3. claim 3 is made to change the editing method by correlation of LchRch accommodative so that it may edit by the editing method suitable for music about the pitch converter of the digital audio signal of a stereo specification.
[0035] Generally, although the correlation of Rch in an edit location does not become the optimal but the tremolo modulation of Rch is worrisome when 2ch(es) are edited into coincidence in the correlation location of Lch in music which is constituted by Lch(es), such as orchestra music, and Rch independence, the phase shift by the difference in the editing point at the time of editing into Lch and Rch independence in a mutually related high location, respectively is not conspicuous.

[0036] In music in which the component same on the contrary as Lch(es), such as music containing vocal, and Rch is contained, although the phase shift by the difference in an editing point is very conspicuous when it edits into Lch and Rch independence, the tremolo modulation at the time of editing into coincidence is not worried.
[0037] This invention establishes a means to detect the cross-correlation between Lch and Rch, it changes whether correlation is thought as important in each channel, or a phase is thought as important so that the fault after each edit may not be conspicuous with the low music of the cross-correlation between 2ch(es), and high music, and it is made to edit by the suitable editing method.
[0038] Drawing 5 is drawing having shown the configuration of the transducer of the pitch converter of the digital audio signal which is one example of invention of claim 3, and is set to drawing. The cross-correlation detector where 20 detects the cross-correlation between a Lch signal and a Rch signal, RAM 21 remembers a Lch input signal to be, and 22 -- edit of Lch -- the actual making of the tea -- the Lch correlating detector which detects correlation of the next cross fade section -- The cross fade circuit where 23 connects by cross fade processing in the editing point of Lch, RAM 24 remembers a Rch input signal to be, and 25 -- edit of Rch -- the actual making of the tea -- the Rch correlating detector which detects correlation of the next cross fade section -- The selector which changes the information about ****** and an edit location to the correlation information between 2ch(es) from which 27 is obtained from the cross-correlation detector 20, and 26 are cross fade circuits which connect by cross fade processing in the editing point of Rch.
[0039] Next, actuation is explained. According to the write-in address given by the write-in address counter 4 and the write-in address counter 16, respectively, a Lch input signal and a Rch input signal are written in RAM21 and RAM24, and are memorized. To the data of Lch and Rch which were memorized to RAM21 and RAM24, the cross-correlation between the signals of 2ch is searched for by the cross-correlation detector 20, and cross-correlation information is outputted. The Lch correlation detector 22 searches for correlation of the cross fade section before and behind the editing point al, and a near [the temporary editing point bl] about the data of Lch memorized to RAM21, detects the location where correlation is the highest, makes the location editing point bl', and sends it to an adder 6 in quest of the die length of the section which compresses with the difference of editing point bl' and the editing point a1. RAM21 reads Signal aluminum from the first address according to the read-out address given by the read-out address counter 5, and reads Signal Bl from the address made to jump by reading the die length of the ****** compression section to coincidence from the Lch correlation detector 22 with an adder 6, and adding to the address. The cross fade circuit 23 performs cross fade processing for this Signal aluminum and Signal Bl before and behind the editing point al, and outputs the Lch data after compression.
[0040] Next, the Rch correlation detector 25 searches for correlation of the cross fade section before and behind the editing point ar, and a near [the temporary editing point br] about the data of Rch memorized to RAM24, detects the location where correlation is the highest, makes the location editing point br', and sends it to a selector 27 in quest of the die length of the section which compresses with the difference of editing point br' and the editing point ar. In a selector 27, using the die length of the compression section obtained from a Lch correlation detector, the die length of the compression section original with Rch obtained from a Rch correlation detector, and the correlation information between 2ch(es) obtained by the cross-correlation detector 20, when correlation is low, when correlation is high, the same compression section as Lch is chosen for the compression section original with Rch, and the die length of the compression section of Rch is sent to an adder 18. RAM24 reads Signal Ar from the first address according to the read-out address given by the read-out address counter 17, and reads Signal Br from the address made to jump by reading the die length of the compression section chosen as coincidence from the selector 27 with the adder 18, and adding to the address. The cross fade circuit 26 performs cross fade processing for this Signal Ar and Signal Br before and behind the editing point ar, and outputs the Rch data after compression.
[0041] According to this example, by editing Lch and Rch independently in the high location of each correlation, when the cross-correlation between Lch and Rch is low, and editing 2 ches in the same location, when a cross-correlation is high, edit suitable for music can be performed and a signal with little degradation is acquired.
[0042]
[Effect of the Invention] As mentioned above, according to invention of claim 1 thru/or claim 3, the pitch converter of a quality digital audio signal with little degradation by the clicking noise, the tremolo modulation, a phase shift, etc. is obtained.

[Translation done.]

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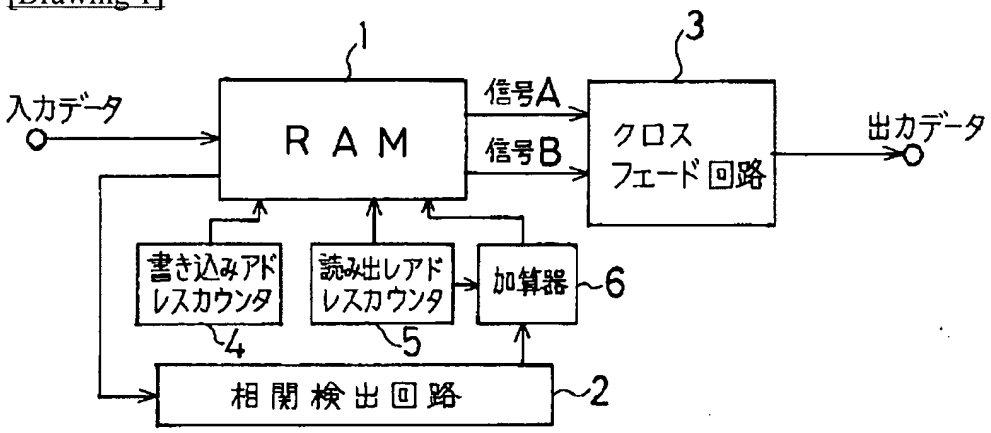
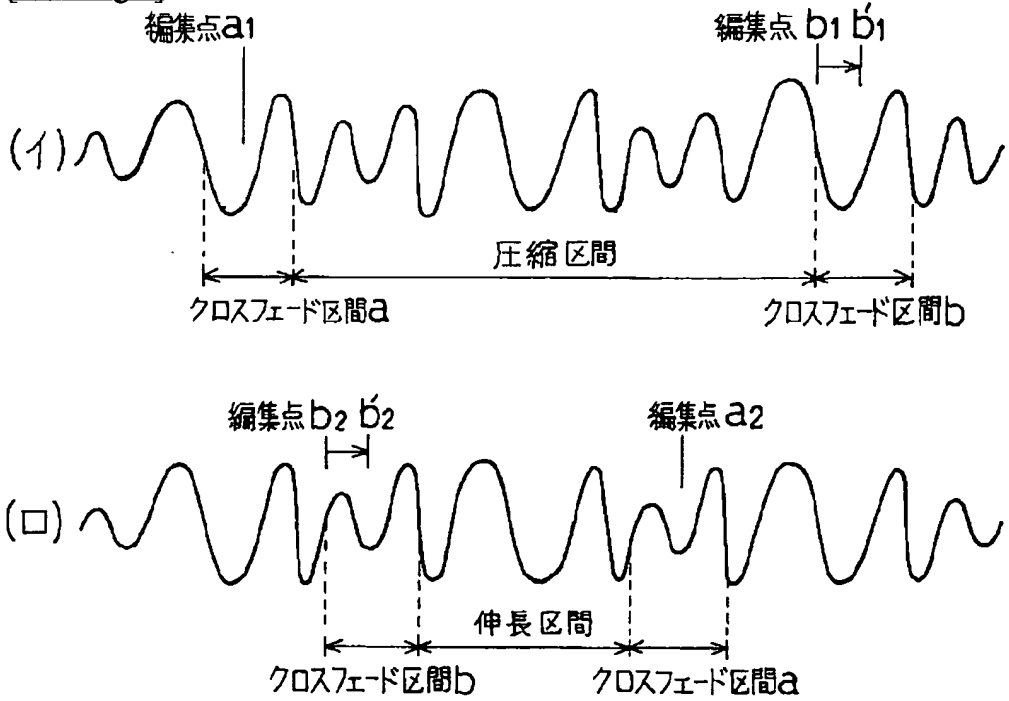
DRAWINGS

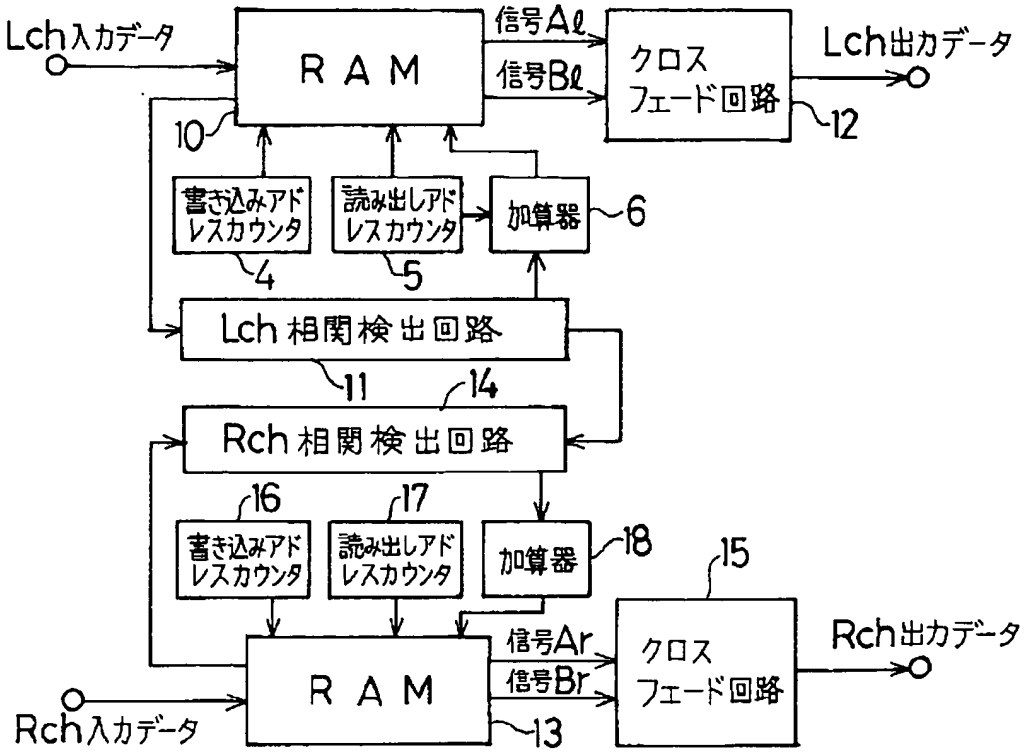
[Drawing 1]



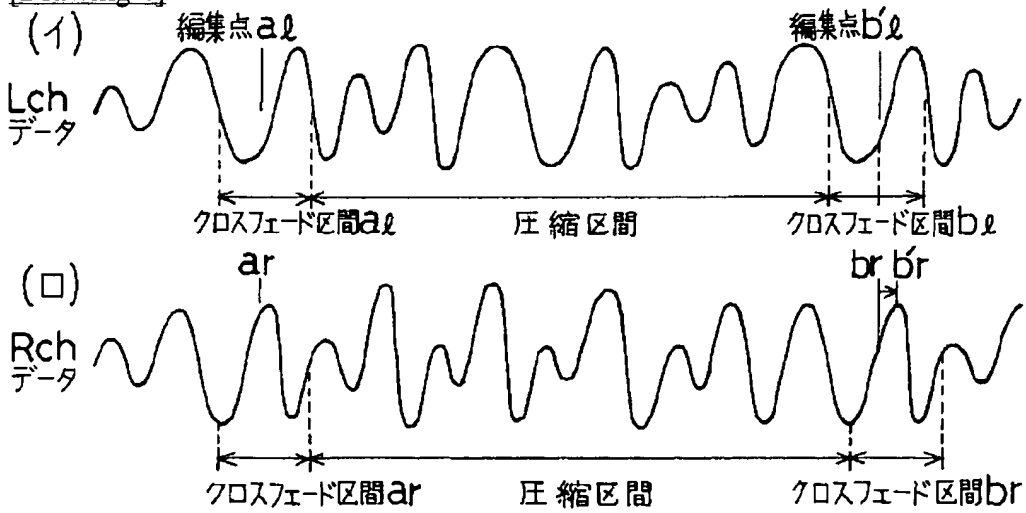
[Drawing 2]



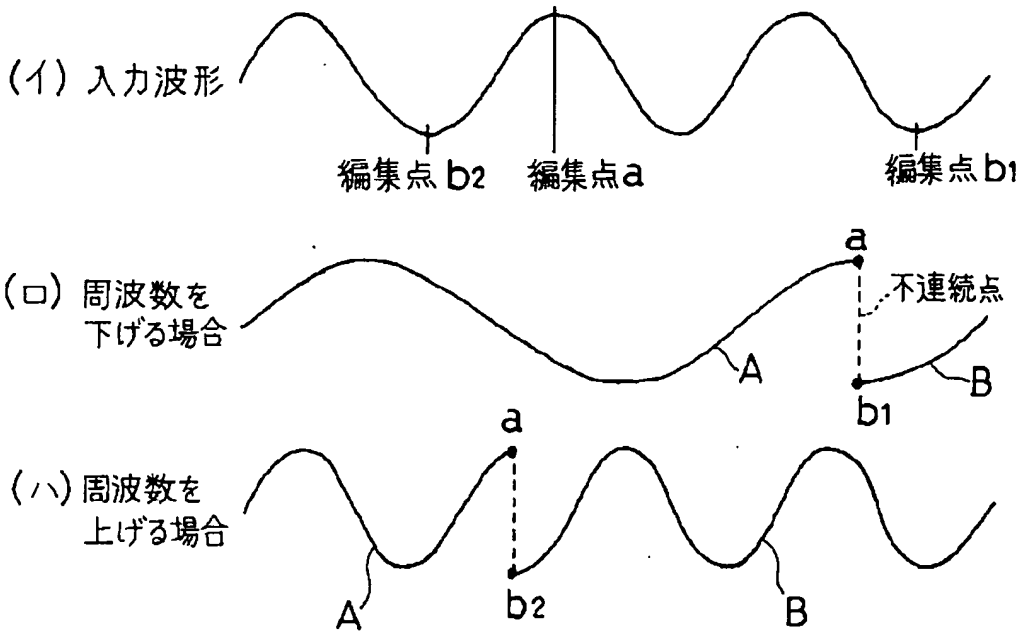
[Drawing 3]



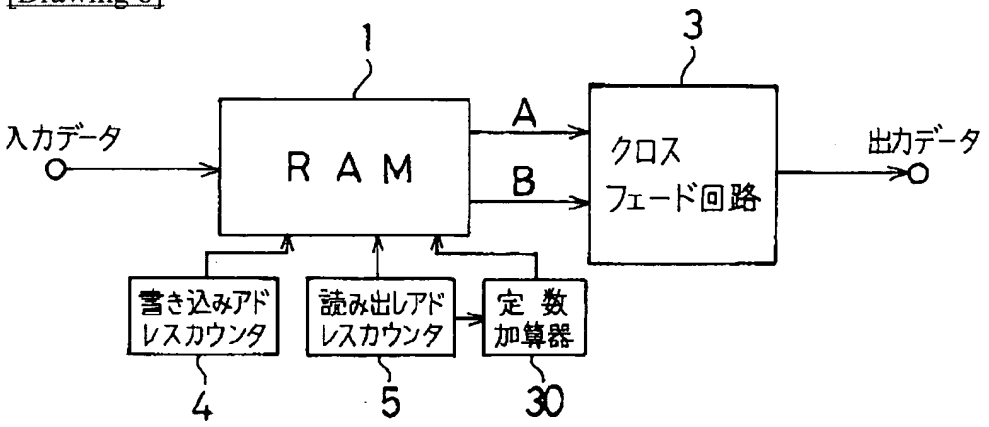
[Drawing 4]



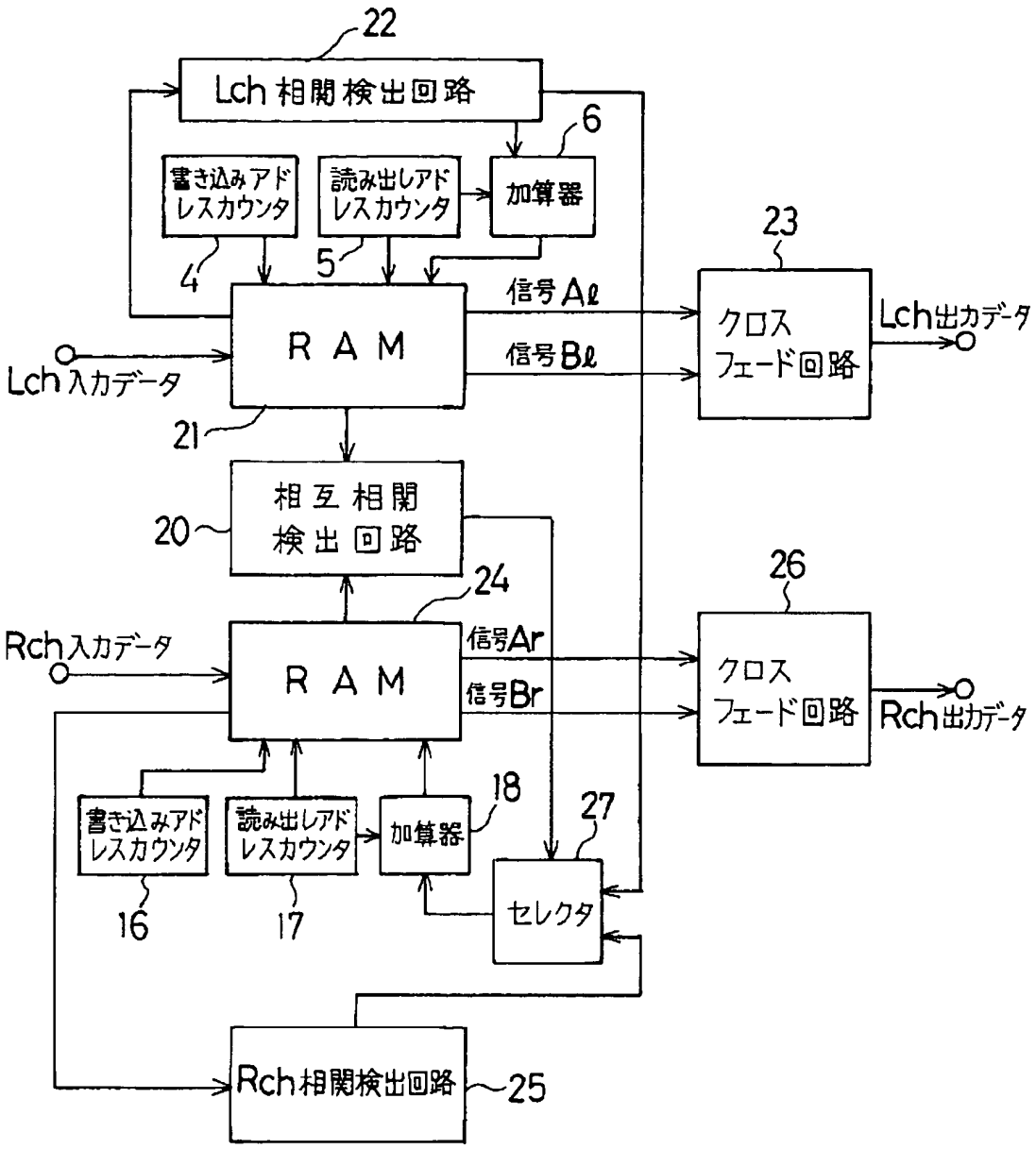
[Drawing 7]



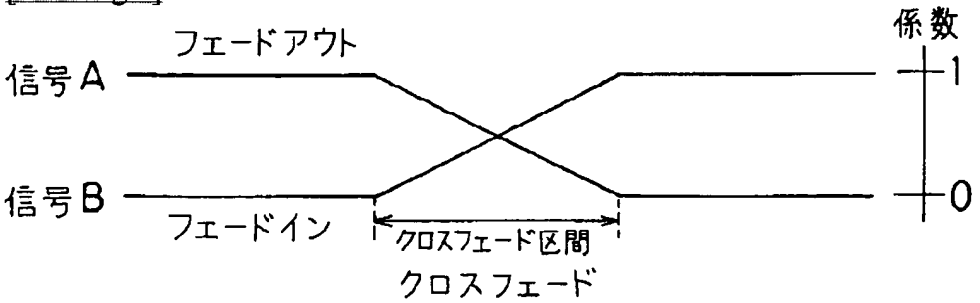
[Drawing 8]



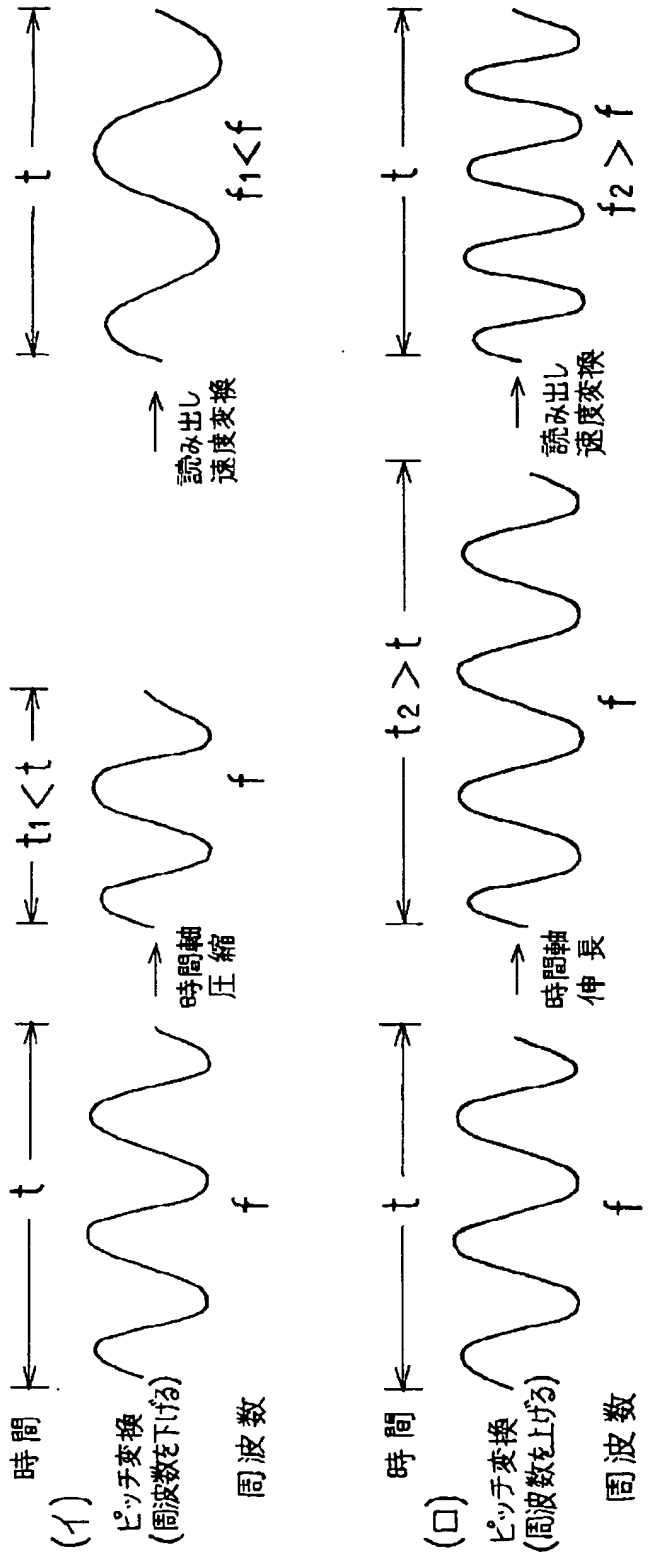
[Drawing 5]



[Drawing 9]



[Drawing 6]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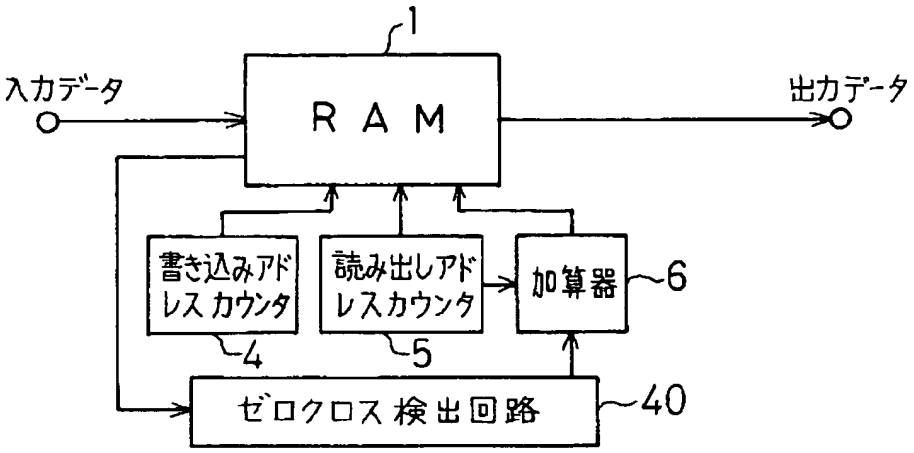
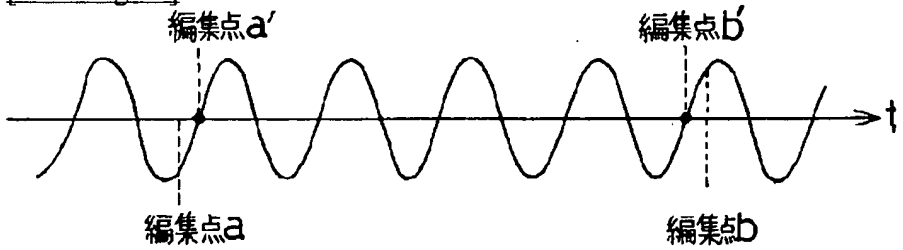
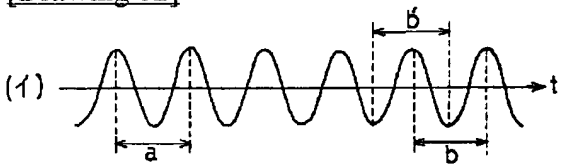
[Drawing 10]

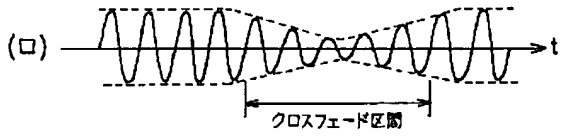


[Drawing 11]



[Drawing 12]





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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block circuit diagram showing the configuration of the time-base-compaction edit part of the pitch transducer by one example of invention of claim 1.
[Drawing 2] It is a wave form chart for explaining the edit actuation in this example.
[Drawing 3] It is the block circuit diagram showing the configuration of the time-base-compaction edit part of the pitch transducer by one example of invention of claim 2.
[Drawing 4] It is a wave form chart for explaining the edit actuation in this example.
[Drawing 5] It is the block circuit diagram showing the configuration of the time-base-compaction edit part of the pitch transducer by one example of invention of claim 3.
[Drawing 6] It is a wave form chart explaining the relation between time-base-compaction elongation and pitch conversion.
[Drawing 7] It is a wave form chart explaining the reason for generating of the break point in the conventional pitch converter.
[Drawing 8] It is the block circuit diagram having shown the configuration of the edit part of the conventional pitch transducer.
[Drawing 9] It is the explanatory view of cross fade.
[Drawing 10] It is the block circuit diagram having shown the configuration of the edit part of the conventional pitch transducer.
[Drawing 11] It is the explanatory view of the situation of connection of the signal by the zero cross method.
[Drawing 12] It is the wave form chart having shown attenuation of the envelope of the data after processing by cross fade.
[Description of Notations]
1 RAM
2 Correlation Detector
3 Cross Fade Circuit
4 Write-in Address Counter
5 Read-out Address Counter
6 Adder
11 Lch Correlation Detector
14 Rch Correlation Detector
20 Cross-correlation Detector
27 Selector

[Translation done.]